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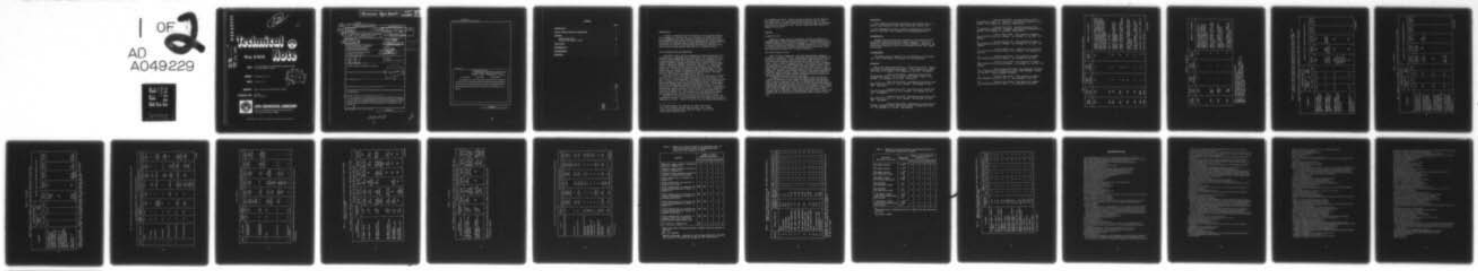

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Technical Note

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TN no. N-1505

title: 1977 INSPECTION OF EXPERIMENTAL MARINE PILING AT PEARL HARBOR, HAWAII

author: Thorndyke Roe, Jr.

date: November 1977

sponsor: Naval Facilities Engineering Command

program nos: 61152N;
DNL Z-R000-147

CIVIL ENGINEERING LABORATORY
NAVAL CONSTRUCTION BATTALION CENTER
Port Hueneme, California 93043

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: TN-1505	2. GOVT ACCESSION NO.: DN244075
3. RECIPIENT'S CATALOG NUMBER: Technical note	
4. TITLE (and Subtitle): 1977 INSPECTION OF EXPERIMENTAL MARINE PILING AT PEARL HARBOR, HAWAII	5. TYPE OF REPORT & PERIOD COVERED: Not Final; Apr 1976—Apr 1977
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(S): Thorndyke Roe, Jr.	8. CONTRACT OR GRANT NUMBER(s): 16 ZR000 01; 17 ZR4126
9. PERFORMING ORGANIZATION NAME AND ADDRESS: CIVIL ENGINEERING LABORATORY, Naval Construction Battalion Center, Port Hueneme, California 93043	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 61152N; DNL Z-R000147
11. CONTROLLING OFFICE NAME AND ADDRESS: Naval Facilities Engineering Command, Alexandria, Virginia 22332	12. REPORT DATE: November 1977
	13. NUMBER OF PAGES: 23
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): 12 29p.	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

DDC RECEIVED JAN 31 1978 F

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Pile structures, marine borers, marine borer prevention, wood preservatives, biodeterioration, and intertidal zone.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The cooperative-, CEL-, and CEL/Industry-treated piles at Pearl Harbor were inspected by a diver in April 1977. The remaining cooperative-treated piles are performing satisfactorily as are many CEL- and CEL/Industry-treated piles. These piles were impregnated with either creosote containing a toxic additive, a solution containing two toxic compounds, or a dual treatment.

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Civil Engineering Laboratory
1977 INSPECTION OF EXPERIMENTAL MARINE PILING AT PEARL HARBOR, HAWAII, by Thorndyke Roe, Jr.
TN-1505 23 pp November 1977 Unclassified

1. Pile structures 2. Marine borers I. DNL Z-R000-147

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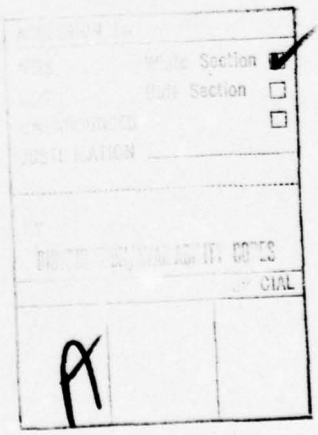
CONTENTS

	Page
INTRODUCTION	1
PILING INSTALLATIONS AND INSPECTIONS	1
FINDINGS	2
Cooperative Piles	2
CEL and CEL/Industry Piles	2
CONCLUSIONS	3
RECOMMENDATION	3
ACKNOWLEDGMENT	3
REFERENCES	3



INTRODUCTION

In order to determine the effectiveness of any proposed preservative treatment for wood piling, it is necessary to expose full-sized piles impregnated with that treatment in marine borer invested waters. To decrease the time required to obtain meaningful data without imposing any artificial conditions upon the evaluation method, exposures are carried out in tropical locations where marine borers and the rate of their attack are much greater than they are in temperate waters.

PILING INSTALLATIONS AND INSPECTIONS

From 1963 to 1976, the Civil Engineering Laboratory monitored two installations of experimentally treated piles. One installation [1] at Coco Solo Annex, Rodman Naval Station, Canal Zone, consisted of piles treated and supplied by the Cooperative Marine Piling Committee, an informal committee composed of representatives from the wood treating industry, The Forest Products Laboratory, and the W. F. Clapp Laboratories. Monitoring of these piles was discontinued after the 1976 inspection. The second installation [2-6] at Waipio Peninsula, Pearl Harbor, Hawaii, consists of Cooperative Marine Piling Committee piles plus four groups of CEL- and CEL/Industry-treated piles. The piles driven at Pearl Harbor are summarized in Table 1.

From the initial inspection through the 1974 inspection, the piles exposed at both sites were inspected visually from the surface of the water [7-14]. One interruption in the exposure at Pearl Harbor occurred when, in August 1972, 120 of the experimental piles were accidentally pulled and brought ashore by Harbor Cleanup Unit HCU-1. Those removed were 42 of the Cooperative Marine Piling Committee piles and the CEL piles driven in 1963 and the 78 CEL piles driven in 1965. An inspection revealed that many of these piles were either lost or were broken and could not be identified. Thus, only 51 of the original 120 piles removed were redriven: four of the 1963 piles (two Cooperative Marine Piling Committee and two CEL), and 47 of the 1965 CEL piles [13].

Because of the difficulties encountered in trying to observe submerged pile surfaces, it was decided that the 1975 inspections would be conducted by a diver. CEL let a contract to the Al Hanson Diving Service*

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*Mr. Hanson has been the inspector of wood piles for the Port of Los Angeles for more than 25 years. Mrs. Hanson, who is both a licensed diver and diver tender, acts as his tender and records his data.

to accomplish this work. Similar contracts were let for the 1976 and 1977 inspections. Mr. Hanson reports the percentage loss of cross-sectional area of each pile caused by borer attack as well as the extent and location of the attack [15]. Splits, checks and other defects or damage are also noted.

FINDINGS

Cooperative Piles

Ammoniacal copper arsenite followed by creosote in Douglas fir, chromated copper arsenate followed by creosote in southern yellow pine, 70-30 creosote-coal tar solution in Douglas fir, 70-30 creosote-coal tar solution in southern yellow pine, and 70-30 creosote-coal tar solution in southern yellow pine followed by sheathing with cupro-nickel alloy have sustained no attack after 14 years of exposure.

CEL and CEL/Industry Piles

After 13 years of exposure, only piles treated with a moderate retention of creosote (17.4 pcf) containing 1% tributyltin oxide and 1% dieldrin are unattacked. Piles treated with a high retention of creosote (28.6 pcf) containing 5% chlordane have attack in the 0 to 1% range. After 12 years of exposure none of the creosote-free treatments are unattacked, but two (5% chlordane plus 1% tributyltin oxide and 5% chlordane plus 2% tributyltin oxide) only have attack in the 0 to 1% range. After 11 years of exposure, none of the piles driven in 1966 are unattacked. However, piles treated with basic zinc sulfate followed by tributyltin oxide, ammoniacal copper arsenite followed by tributyltin oxide, and ammoniacal cooper arsenite followed by 70-30 creosote-coal tar solution have attack in the 0 to 1% range.

In summary, 50 of the 69 (72%) CEL/Industry piles treated with creosote or solutions of toxic agents in creosote have been attacked after 13 years of exposure; 23 of the 35 (66%) single and combination creosote-free treated piles and 9 of the 12 (75%) creosote-plus-additive treated piles have been attacked after 12 yars of exposure; 34 of the 48 (71%) single and combination (dual-treated) creosote-free treated piles and 3 of the 12 (25%) piles treated with a high retention of 70-30 creosote-coal tar solution or with ammoniacal copper arsenite plus 70-30 creosote-coal tar solution have been attacked after 11 years of exposure.

CONCLUSIONS

1. Piles treated with creosote containing a toxic additive are, in general, performing better than those treated with creosote only.

2. Piles impregnated (1) with a solution containing two toxic compounds, or (2) with a dual treatment are performing equally well.

RECOMMENDATION

Because several preservative treatments of wood piling are still giving good protection in the Pearl Harbor exposure, it is not yet possible to identify the best two or three treatments. Therefore, the annual diver inspections, which can be performed at small cost, should be continued.

ACKNOWLEDGMENT

The author wishes to thank Mr. D. Kim, Maintenance Control Department, Public Works Center, Pearl Harbor, for his assistance.

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Table 1. Experimentally Treated Piles Driven at Pearl Harbor

Year Driven	Source of Piles	Number of Treatments	Piles per Treatment	Total Piles	Summary of Treatments
1963	Coop	10	6	60	Inorganic salt followed by creosote (double treatment); 70-30 creosote-coal tar solution; phenylmercuric; oleate dissolved in 70-30 creosote-coal tar solution; 70-30 creosote-followed by sheathing with 90:10 cupro-nickel alloy
1963	CEL	1	6	6	Type III creosote
1964	CEL	9	6	54	Creosote solutions of specific organic compounds and/or metal organic compounds
1964	OWPC	1 1 1	4 5 6	15	Creosote solutions of specific organic and metal organic compounds
1965	CEL	13	6	78	Solutions of specific organic and metal organic compounds in xylene or creosote
1966	CEL	2	6	12	Double treatment: Copper sulfate followed by tributyltin oxide
1966	BCCWP	1	6	6	Chromated copper arsenate (Type B)
1966	AZLS	3	6	6	Basic zinc sulfate

continued

Table 1. Continued

Year Driven	Source of Piles	Number of Treatments	Piles per Treatment	Total Piles	Summary of Treatments
1966	AZLS	3	6	18	Ammoniacal copper arsenite; 70-30 creosote-coal tar solution; double treatment: ammoniacal copper arsenite followed by 70-30 creosote-coal tar solution
1966	AZLS/ CEL	1	6	6	Double treatment: basic zinc sulfate followed by tributyltin oxide
1966	BCCWP/ CEL	1	6	6	Double treatment: chromated copper arsenate (Type B) followed by tributyltin oxide
1966	JHB/ CEL	1	6	6	Double treatment: ammoniacal copper arsenite followed by tributyltin oxide

[a]Coop = Cooperative Marine Piling Committee.
CEL = Civil Engineering Laboratory.
OWPC = Osmose Wood Preserving Company of America.
BCCWP = British Columbia Clean Wood Preservers, Ltd.
AZLS = American Zinc, Lead, and Smelting Co.
JHB = J. H. Baxter and Co.

Table 2. Results of 1977 Inspection of Cooperative Piles at Pearl Harbor, Plus One Set of Piles Treated With Creosote by CEL (installed in 1963)

(Mart = Martesia; Lim = Limnoria; Ter = Teredo; ML = Mud Line; TA = Tide Area)

Treatment	Retentions (lb/ft^3)				Percent Loss of Cross-Sectional Area for -				
	Cooperative Assay		CEL Assay						
	Oil	Salt	Oil	Salt	Piling No. 1	Piling No. 2	Piling No. 3	Piling No. 4	Piling No. 5
Ammoniacal copper arsenite followed by creosote in Douglas fir	16.2	6.9	9.7	–	0%	0%	0%		
Chromated copper arsenate followed by creosote in Douglas fir	8.4	2.7	2.7	–	10%: TA to ML, Lim,Mart	26%: TA,Ter, Mart,Lim	2%: ML, dormant		
Chromated copper arsenate followed by creosote in southern yellow pine	23.2	2.7	17.3	–	0%: Pile has been hit and is broken 4 ft from ML	0%	0%		
70-30 creosote-coal tar solution in Douglas fir	15.3	–	11.1	–	0%	0%	0%		

continued

Table 2. continued

(Mart = Martesia; Lim = Limnoria; Ter = Teredo; ML = Mud Line; TA = Tide Area)

Treatment	Retentions (lb/ft^3)				Percent Loss of Cross-Sectional Area for -				
	Cooperative Assay		CEL Assay						
	Oil	Salt	Oil	Salt	Piling No. 1	Piling No. 2	Piling No. 3	Piling No. 4	Piling No. 5
70-30 creosote-coal tar solution in southern yellow pine	17.7	–	13.5	–	8%; TA, Lim,Mart	2%: TA, TA,Lim			
70-30 creosote-coal tar solution containing 1% phenylmercuric oleate[a] in Douglas fir	20.7	–	18.5	–	9%: TA,Lim	0%	1%: TA,Lim		
70-30 creosote-coal tar solution containing 1% phenylmercuric oleate[a] in southern yellow pine	24.1	–	18.5	–	0%				
70-30 creosote-coal tar solution containing 5% phenylmercuric oleate[a] in Douglas fir	13.0	–	10.0	–	2%: TA, Mart,Lim				

continued

Table 2. continued

(Mart = Martesia; Lim = Limnoria; Ter = Teredo; ML = Mud Line; TA = Tide Area)

Treatment	Retentions (lb/ft^3)				Percent Loss of Cross-Sectional Area for -				
	Cooperative Assay		CEL Assay						
	Oil	Salt	Oil	Salt	Piling No. 1	Piling No. 2	Piling No. 3	Piling No. 4	Piling No. 5
70-30 creosote-coal tar solution containing 5% phenylmercuric oleate[a] in southern yellow pine	27.5	–	22.1	–	9%: TA to ML, Lim	0%			
70-30 creosote-coal tar solution in southern yellow pine followed by sheathing with cupro-nickel alloy					0%				
CEL creosote in Douglas fir					3%: TA to ML, Mart,Lim	0%	4%: TA, Lim,Mart (dead)	2%: TA,Lim	4%: TA, Lim,Mart

[a]Nominal percentages. Analyses of core borings showed that considerably less than the nominal percentage got into the wood. No individual retention figures were reported [1].

Table 3. Results of 1977 Inspection of CEL- and Industry-Treated Piles at Pearl Harbor (installed in 1964)

(Lim = Limnoria; Mart = Martesia; Ter = Teredo; TA = Tide Area; ML = Mud Line)

Group[a]	Creosote Additive	Creosote Retention (lb/ft^3)	Additive Retention (lb/ft^3)	Percent Loss of Cross-Sectional Area for –					
				Piling No. 1	Piling No. 2	Piling No. 3	Piling No. 4	Piling No. 5	Piling No. 6
1	None	32.9	0.00	3%: TA,Lim	2%: TA,Lim	1-2%: TA	4%: high TA, Lim	3%: high TA, Lim	3%: TA hole, Lim
2	5% chlordane	28.6	1.4	0%	0%	1%: TA,Lim	1%: TA,Lim	0%	0%
3	2.5% chlordane	28.5	0.7	1%: slight etching, 1 Mart in knothole	0%	2%: TA,Lim,Mart	3%: TA,Lim,Mart	0%	0-1%: TA, 2 small Mart hole
4	1.25% chlordane	26.3	0.3	0%	0%	0%	2%: high TA, Lim	0-1%: TA	3%: TA, slight split, Lim
5	30% copper naphthenate	8.3	0.27[b]	0%	4%: TA,Lim	3%: TA,Lim,Mart	4%: TA to ML, Mart,Lim	4%: TA to 3%: ML,Lim,Mart	0%
6	15% copper naphthenate	9.4	0.15[b]	7%: TA,Lim,Mart	0%	38%: TA,Lim,Mart 4%: ML,Lim	2%: TA,Lim,Mart	12%: TA,Lim,Mart	65%: TA, tapers to 6%: ML,Lim,Mart
7	7.5% copper naphthenate	10.9	0.09[b]	86%: TA,Lim	0%	45%: 15 in. high TA 3-4%: 12 in. below 2%: ML,Lim	3%: TA,Lim	4%: TA,Lim 2%: ML,Lim	2-3%: TA,Lim,Mart

continued

Table 3. Continued

Group[a]	Creosote Additive	Creosote Retention (lb/ft^3)	Additive Retention (lb/ft^3)	Percent Loss of Cross-Sectional Area for –					
				Piling No. 1	Piling No. 2	Piling No. 3	Piling No. 4	Piling No. 5	Piling No. 6
8	14% copper naphthenate 1% tributyltin oxide	14.8	0.23[b] 0.15	15%: TA, 9 in. hole. Pile split. 5-3%: -12 in. to ML,Mart	7%: TA,Lim, Mart,Ter	2%: TA,Lim, Mart	17%: TA,Lim, Mart, few Ter	88%: TA,Lim,Mart	36%: TA, tapers to 4%: ML,Lim,Mart
9	7% copper naphthenate 0.5% tributyltin oxide	8.6	0.07[b] 0.08	1%: TA	6-7%: TA,Lim,Mart	1%: Lim	3%: TA,Lim	58%: TA, tapers to 2%: ML,Lim,Mart	18%: TA,Lim,Mart; some small Mart to ML
10	None	18.6	0.00	24%: TA, tapers to 12%: ML,Mart,Lim	26%: TA, tapers to 3%: ML,Lim, few Mart	47%: 20 in. TA, Lim, few Mart 65%: ML,Lim	25%: TA through ML,Lim,Mart		
11	1% tributyltin oxide	13.9	0.14	11%: TA,Lim	46%: TA,Lim,Mart 5%: ML,Lim	18%: TA,Lim, very few Mart 5%: ML,Lim	78%: TA, tapers to 4%: ML,Lim	38%: TA	
12	1% tributyltin oxide 1% dieldrin	17.4	0.18 0.18	0%	0%	0%	0%	0%	0%

[a] Treatment groups 1 through 9 had six Douglas fir piles each; there were four pine piles in group 10, five in group 11, and six in group 12.

[b] As metallic copper.

Table 4. Results of 1977 Inspection of CEL-Treated Piles at Pearl Harbor (installed in 1965)[a]

(Lim = Limnoria; Mart = Martesia; Ter = Teredo; TA = Tide Area; ML = Mud Line)

Treatment (Solutions in Xylene)	Retention (lb/ft^3)	Percent Loss of Cross-Sectional Area for -					
		Piling No. 1	Piling No. 2	Piling No. 3	Piling No. 4	Piling No. 5	Piling No. 6
4% copper oxinate	0.87[b]	1%: TA, Lim,Mart	1%: TA,Lim	1%: TA,Lim	4%: TA, Mart,Lim	3%: TA, Mart,Lim	0%
2% copper oxinate	0.49[b]	1%: TA,Lim	3%: TA,Lim	13%: TA,Mart, Lim,Ter	0%	3%: TA,Lim	1%: TA,Lim
2% copper oxinate 2% tributyltin oxide	0.25[b] 0.25	8%: TA, Lim,Mart 12%: ML,Lim	8%: TA,ML, Lim,Mart	3%: TA,Lim	2%: TA,Mart 3%: ML,Lim	6%: TA tapers to 5%: ML,Mart, Lim	5%: TA, Lim,Mart
3% copper oxinate 1% Victoria green base	0.69[b] 0.26	2%: TA,Lim	4%: TA, Mart,Lim		0%	1%: TA,Lim	4%: TA,Lim
5% chlordane 1% tributyltin oxide	1.3 0.27	1%: TA,Lim	0%	0-1%: TA,Mart	0%	0%	0%
5% chlordane 2% tributyltin oxide	1.5 0.62	0%	1%: TA,Mart (dead)	0%	0%	0%	0%

continued

Table 4. continued

(Lim = Limnoria; Mart = Martesia; Ter = Teredo; TA = Tide Area; ML = Mud Line)

Treatment (Solutions in Xylene)	Retention (lb/ft^3)	Percent Loss of Cross-Sectional Area for -					
		Piling No. 1	Piling No. 2	Piling No. 3	Piling No. 4	Piling No. 5	Piling No. 6
1.5% copper oxinate 0.5% Victoria green base 50% creosote	0.27[b] 0.09 9.2	4%: ML,Lim	10%: TA to ML,Lim, Mart,Ter	5%: TA,Lim	5%: TA to ML, Mart,Lim	5%: TA, Mart,Lim 3%: ML, Mart,Lim	7%: TA to 15%: ML,Lim, Mart
0.75% copper oxinate 0.25% Victoria green base 75% creosote	0.25[b] 0.08 24.7	0%	3%: TA, split,Lim 2%: ML,Lim	0%	0%	2%: TA,Lim 3%: ML,Lim	8%: TA, Mart,Lim tapers to 4%: ML,Lim

[a]These piles were accidentally pulled in August 1972 and redriven in May 1973.

[b]As metallic copper.

Table 5. Results of 1977 Inspection of CEL- and Industry-Treated Piles at Pearl Harbor (installed in 1966)

Treatment	Retention (lb/ft^3)	Percent Loss of Cross-Sectional Area for –					
		Piling No. 1	Piling No. 2	Piling No. 3	Piling No. 4	Piling No. 5	Piling No. 6
Chromated copper arsenate, Type B	0.50	100%: TA,Lim,Ter 85%: ML,Lim,Ter	100%: top of pile missing 40%: ML,Lim,Mart	5%: TA,Mart,Lim	100%: TA,Lim 60%: ML,Lim	96%: TA,Lim 6%: low TA, Lim 26%: ML,Lim	3%: TA,Mart 1%: ML,Mart
Basic zinc sulfate	2.77	2%: TA,Mart	0%	2%: TA,Mart	0-1%: TA,Lim	3%: TA,Mart	2%: TA,Mart
Ammoniacal copper arsenite	0.51	1%: TA,Mart	2%: TA,Lim,Mart	2%: TA,Lim 4%: ML,Lim	2%: TA,Mart	3%: TA,Lim	3%: TA,Mart
Chromated copper arsenate, Type B Tributyltin oxide	0.50 0.13	0%	0%	4%: TA,Lim	1%: TA,Lim	0%	2%: TA,Lim
Basic zinc sulfate Tributyltin oxide	2.66 0.09	0%	0%	0%	0%	0%	0-1%: TA,Lim
Ammoniacal copper arsenite Tributyltin oxide	0.51 0.11	0%	0%	0%	0%	0%	1%: TA,Lim
70-30 creosote-coal tar	31.7	0%	9%: TA,Lim,Mart	0%	0%	3%: TA,Lim	0%
Ammoniacal copper arsenite 70-30 creosote-coal tar	0.51 19.6	0%	1%: TA	0%	0%	0%	0%
Copper sulfate Tributyltin oxide	0.06[a] 0.19	11%: TA,Lim,Mart	6%: TA,Lim	4%: TA,Lim 2%: ML,Lim	3%: TA,Lim	2%: TA,Lim	5%: TA,Lim
Copper sulfate Tributyltin oxide	0.03[a] 0.20	5%: TA,Lim	5%: TA,Lim	3%: TA,Lim,Mart	92%: high TA, Lim	1%: TA	70%: high TA, split 2%: ML

[a] As metallic copper.

Table 6. Summary of Inspection Results on Cooperative Piles at Pearl Harbor, Plus One Set of Piles Treated With Creosote by CEL (installed in 1963)[a]

Treatment	Number of Piles Reported Attacked in -				
	1973	1974	1975	1976	1977
Ammoniacal copper arsenite followed by creosote in Douglas fir	0	0	0	0	0
Chromated copper arsenate followed by creosote in Douglas fir	2	0	1	3	3
Chromated copper arsenate followed by creosote in southern yellow pine	0	0	0	0	0
70-30 creosote-coal tar solution in Douglas fir	1	0	0	0	0
70-30 creosote-coal tar solution in southern yellow pine	2	0	0	2	2
70-30 creosote-coal tar solution containing 1% phenylmercuric oleate[c] in Douglas fir	NR[b]	NR	0	2	2
70-30 creosote-coal tar solution containing 1% phenylmercuric oleate[c] in southern yellow pine	NR	NR	0	0	0
70-30 creosote-coal tar solution containing 5% phenylmercuric oleate[c] in Douglas fir	NR	NR	0	0	1
70-30 creosote-coal tar solution containing 5% phenylmercuric oleate[c] in southern yellow pine	NR	NR	1	1	1
70-30 creosote-coal tar solution in southern yellow pine followed by sheathing with cupro-nickel alloy	NR	NR	0	0	0
CEL creosote in Douglas fir	NR	3	1	3	4

[a]These piles were accidentally pulled in August 1972 and redriven in May 1973.

[b]NR = not reported.

[c]Nominal percentages. Analyses of core borings showed that considerably less than the nominal percentage got into the wood [11].

Table 7. Summary of Inspection Results on CEL- and Industry-Treated Piles at Pearl Harbor (installed in 1964)

Group[a]	Creosote Additive	Creosote Retention (lb/ft^3)	Additive Retention (lb/ft^3)	Number of Piles Reported Attacked in -						
				1971	1972	1973	1974	1975	1976	1977
1	None	32.9	0	1	1	1	0	4	5	6
2	5% chlordane	28.6	1.4	0	2	1	0	1	0	2
3	2.5% chlordane	28.5	0.7	0	1	2	0	2	2	4
4	1.25% chlordane	26.3	0.3	0	2	0	0	3	2	3
5	30% copper naphthenate	8.3	0.27b	0	2	1	0	2	4	4
6	15% copper naphthenate	9.4	0.15b	2	3	3	0	4	4	5
7	7.5% copper naphthenate	10.9	0.09b	1	2	2	1	3	5	5
8	14% copper naphthenate 1% tributyltin oxide	14.8	0.23b 0.15	1	2	5	0	5	5	6
9	7% copper naphthenate 0.5% tributyltin oxide	8.6	0.07b 0.08	0	2	2	0	4	4	6
10	None	18.6	0	0	1	4	3	4	4	4
11	1% tributyltin oxide	13.9	0.14	0	1	4	2	5	5	5
12	1% tributyltin oxide 1% dieldrin	17.4	0.18 0.18	0	0	0	0	0	0	0

[a]Treatment groups 1 through 9 had six Douglas fir piles each; there were four pine piles in group 10, five in group 11 and six in group 12.

[b]As metallic copper.

Table 8. Summary of Inspection Results on CEL-Treated Piles at Pearl Harbor (installed in 1965)[a]

Treatment (Solutions in Xylene)	Retention (lb/ft^3)	Number of Piles Reported Attacked in -				
		1973	1974	1975	1976	1977
4% copper oxinate	0.87[b]	0	2	1	3	5
2% copper oxinate	0.49[b]	4	2	2	3	5
2% copper oxinate 2% tributyltin oxide	0.25[b] 0.25	4	0	0	4	6
3% copper oxinate 1% Victoria green base	0.69[b] 0.26	3	2	1	2	4
5% chlordane 1% tributyltin oxide	1.3 0.27	0	2	0	0	2
5% chlordane 2% tributyltin oxide	1.5 0.62	0	2	1	1	1
1.5% copper oxinate 0.5% Victoria green base 50% creosote	0.27[b] 0.09 9.2	6	4	4	6	6
0.75% copper oxinate 0.25% Victoria green base 75% creosote	0.25[b] 0.08 24.7	4	4	1	3	3

[a]These piles were accidentally pulled in August 1972 and redriven in May 1973.

[b]As metallic copper.

Table 9. Summary of Inspection Results on CEL- and Industry-Treated Piles at Pearl Harbor (installed in 1966)

Treatment	Retention (lb/ft^3)	Number of Piles Reported Attacked in -						
		1971	1972	1973	1974	1975	1976	1977
Chromated copper arsenate, Type B	0.50	3	3	3	5	4	6	6
Basic zinc sulfate	2.77	0	0	3	2	0	2	5
Ammoniacal copper arsenite	0.51	0	0	3	2	1	4	6
Chromated copper arsenate, Type B Tributyltin oxide	0.50 0.13	0	0	0	2	1	2	3
Basic zinc sulfate Tributyltin oxide	2.66 0.09	0	0	0	1	0	0	1
Ammoniacal copper arsenite Tributyltin oxide	0.51 0.11	0	0	0	0	0	0	1
70-30 creosote-coal tar	31.7	0	0	0	1	1	1	2
Ammoniacal copper arsenite 70-30 creosote-coal tar	0.51 19.6	1	0	1	0	0	0	1
Copper sulfate Tributyltin oxide	0.06[a] 0.19	2	4	3	1	2	5	6
Copper sulfate Tributyltin oxide	0.03[a] 0.20	0	1	0	2	3	5	6

[a]As metallic copper.

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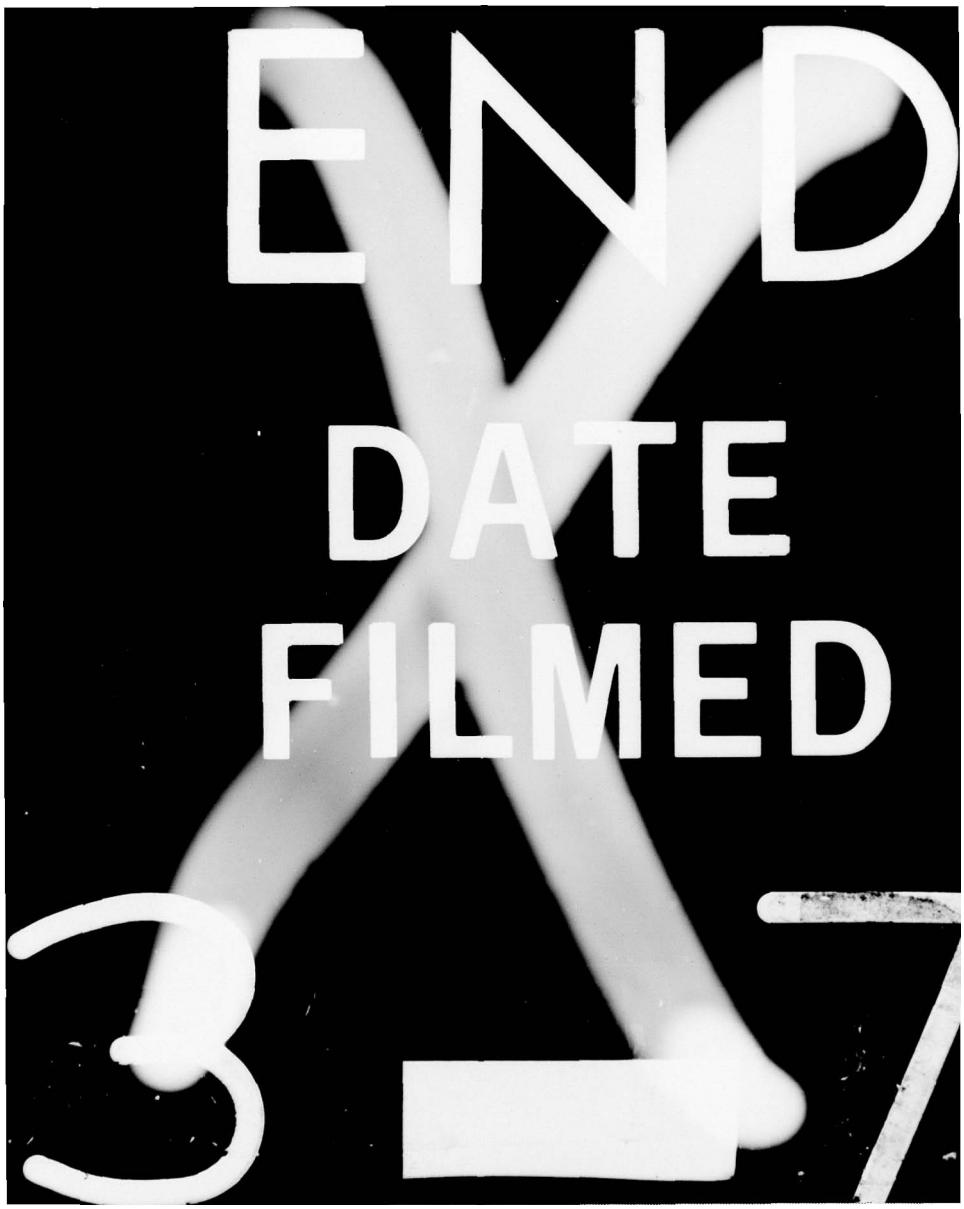
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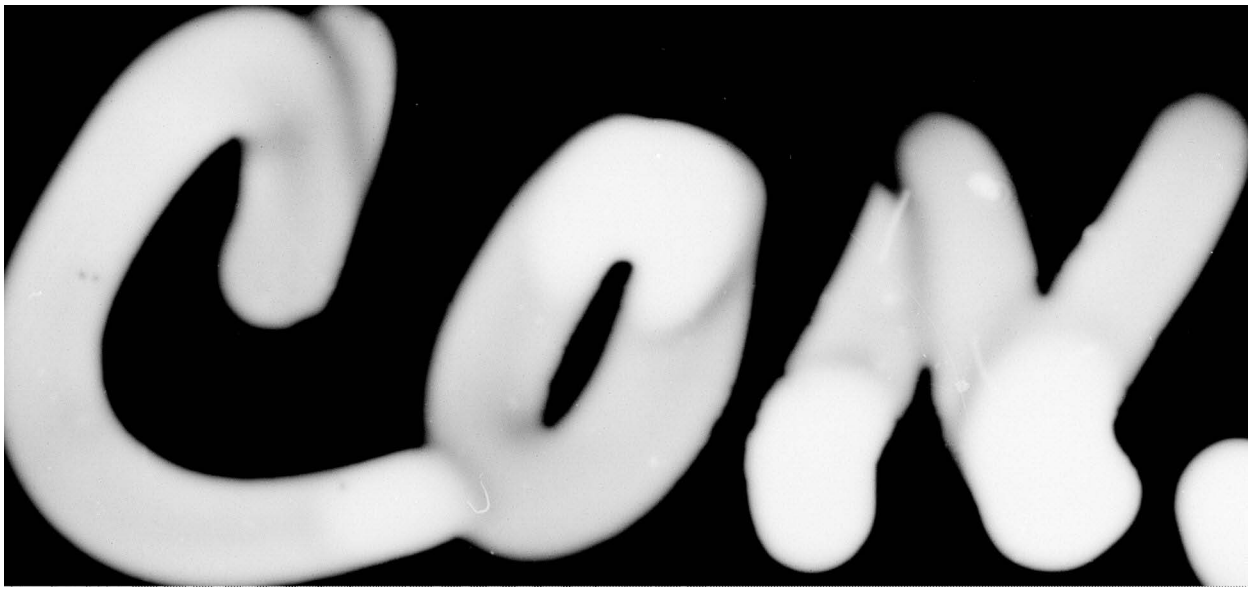
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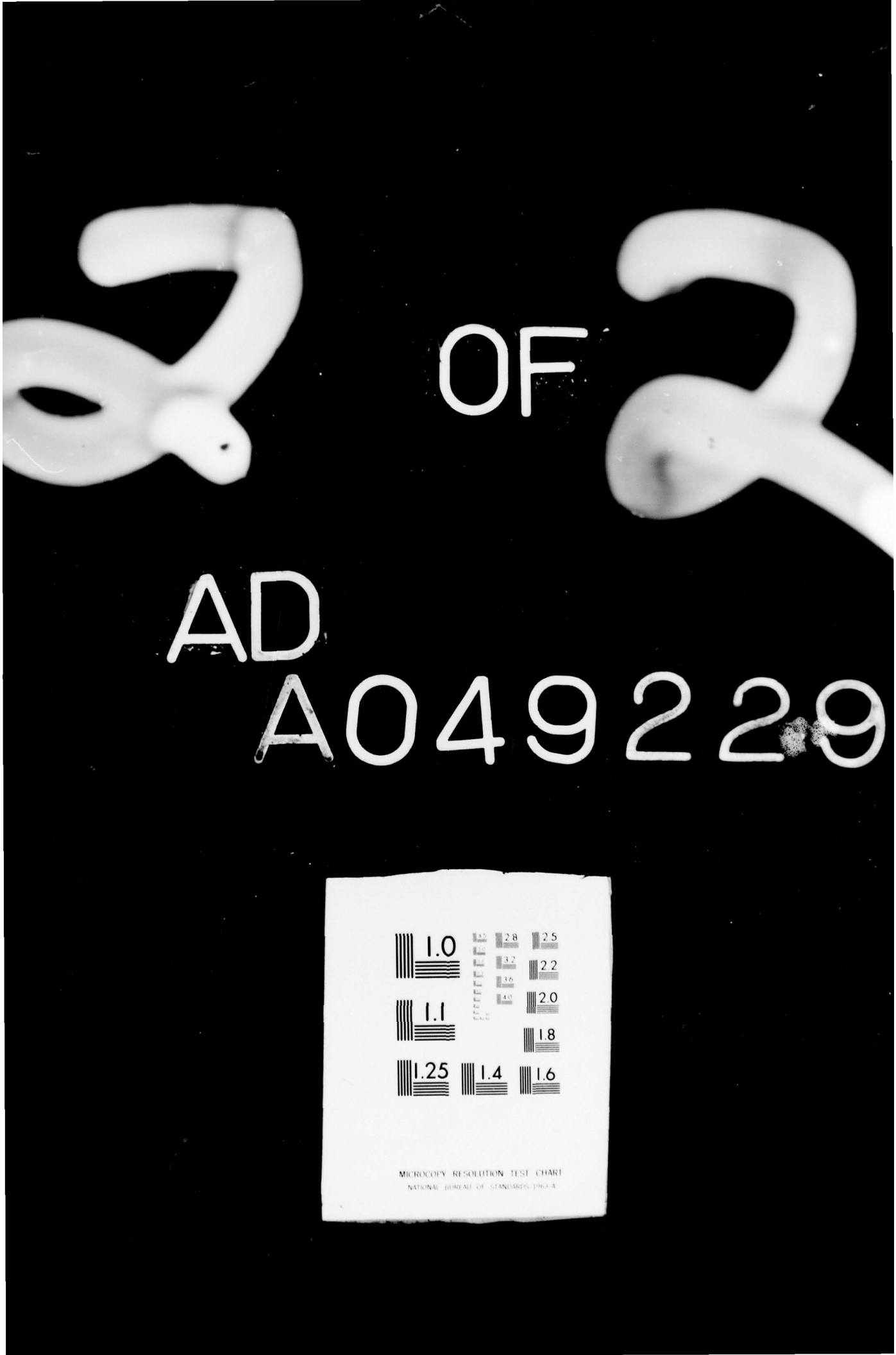
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1. Please make the following pen and ink corrections:

AD-A049 229

N-1505, Page 6: 2nd column, 1st entry should be JHB vice AZLS
Page 7: 3rd column, 1st entry should be 0.9 vice 6.9

~~N-1538, Page 6: 2nd column, 2nd entry should be JHB vice AZLS~~
~~Page 7: 3rd column, 1st entry should be 0.9 vice 6.9~~

Peter D. Triem

PETER D. TRIEM
By direction